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Place-based research faces multiple threats, including both natural and global health hazards and political conflicts, which may disrupt fieldwork. The current COVID-19 pandemic shows how these threats can drastically affect social-ecological research activities given its engagement with different local stakeholders, disciplines, and knowledge systems. The crisis reveals the need for adaptive research designs while also providing an opportunity for a structural shift towards a more sustainable and inclusive research landscape.

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Every academic discipline that depends on place-based research can be hampered by crises and associated restrictions. This holds true for social-ecological research that typically relies on social and physical interaction on site, as it requires deep engagement with different stakeholders, ecosystems, disciplines, and knowledge systems. For this reason, it is particularly vulnerable to limitations on social contact and mobility.

The COVID-19 pandemic is one such crisis that currently demonstrates a number of challenges for place-based social-ecological research, ranging from the inability to collect biophysical data to reducing or eliminating the possibility to conduct participatory, ethnographic research with local stakeholders in the field (e. g., Douglas et al. 2020). While COVID-19 has drawn significant attention to the discussion on how to conduct place-based social-ecological research, it is not the only crisis with the potential to disrupt this kind of research. Place-based research has been, and likely will be affected by a variety of disruptive events, including, but not limited to, natural hazards, terrorist attacks, political conflicts and public health issues.

The global research community can learn from existing experiences with crisis-related disruptions of research. For example, Roxburgh et al. (2020) illustrate how the 2015 earthquake in Nepal forced them to transition their focus from pre- to post-disaster research, stressing the importance of flexibility, risk assessment and ethical considerations. Bachmann (2011) outlines how fieldwork challenges arising from the Kenyan post-election crisis in early 2008 induced him, amongst other things, to refine the thematic focus on issues of regional integration in East Africa and the role of the EU in this and expand the scales of his research to the sub-regional and continental level. For the same country, Chambers (2020) examines the impact of the political turmoil in 2017 on his data collection and encourages utilizing adaptive methodologies to circumvent such challenges. In Australia the recent bushfires have derailed place-based research projects for months or years (Lewis 2020). Together, these examples illustrate that useful experiences with anticipating and navigating crisis-related repercussions exist. However, until now they remain scarce and limited to regions or countries and a particular limited research subject.

Overall, a better acknowledgement of how a crisis limits, but also legitimates and enables specific actions, is required for effectively overcoming crisis-related restrictions. Our aim here is to reflect on strategies adopted to minimize setbacks in research outcomes and to offer recommendations for designing future place-based social-ecological research that is more resilient to crises.

Recommendations for curbing the impacts of disruptions

While we developed and reflected the following recommendations from the beginning of the COVID-19 pandemic, they are meant to provide guidance on how to constructively deal with a variety of disruptions in the future.

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Minimize the impact of disruptions through adaptive research design and risk assessment

Designing and managing research projects in a way that reduces the impact of disruptions requires the recognition of risks and uncertainties and an increase in flexibility and adaptive capacity. In this way, the aim is not to minimize the influence of crisis-related setbacks on research outcomes for both ongoing and future research activities. Iterative and adaptive study design and management structures maintain the capacity to conduct research, that is, to collect data, to continue collaborations and to engage with local actors in a given study area. Thus, it enables and strengthens resilience against shocks and disturbances (Walker and Salt 2006). In the field of resilience research, a range of principles have been developed that foster resilience in social-ecological systems, some of which might also be relevant to empirical research projects (Biggs et al. 2015). We would like to highlight the following three principles:

- increasing diversity in teams, collaborations and research methods, enabling participation, innovation and learning (including transdisciplinarity and citizen science),
- balancing connectivity and modularity (e. g., creating tight links with partners, participants and researchers at the eye-level but avoiding overly rigid connectivity), and
- applying adaptive complex systems thinking, which recognizes unpredictability and feedbacks (e. g., risk assessment and scenario planning).

Furthermore, flexibility is essential for both navigating ongoing research activities through a crisis and preparing future research projects for unknown disturbances. The ability to re-organize research activities with little or no impact on research outcomes can, for example, be achieved through a modular design in research projects from the onset. Then a project can be divided into subprojects (e. g., individual chapters of an article-based PhD project) with varying degrees of mutual dependency. Other than in a sequential project design, where all subprojects build directly upon each other, a modular setup allows for studying the same topic from different perspectives, so that they are related, but not critically dependent on outcomes of previous subcomponents. A modular design enables researchers to switch the order of subprojects, which adds to the flexibility with regard to temporal disruptions. If modularity is not an option, an adaptive design and manage- >

FIGURE 1: Group discussions, such as this one in the northern Ethiopian highlands within the scope of the research group *MigSoKo (www.ufz.de/migsoko)*, are not possible during the COVID-19 pandemic. Crises like the current pandemic can impede participatory place-based research methods, consequently calling for alternative approaches.

ment can include back-up plans in anticipation of, or response to disruptions. As many disruptions are local, such back-up plans could include alternative case study regions (e. g., changing to places that are more accessible or safe), when feasible and compatible with the given research questions. Besides changing the geographic focus, adapting research questions by turning the disruption into an opportunity might be an option.[1] Scenario planning can be a useful method for unpredictable situations, which are not atypical for social-ecological systems (e. g. Peterson et al. 2003). Applying scenario planning to research processes has the potential to explicitly acknowledge the existence and impact of uncertainties on research as well as to identify and activate agency over the research process, which is often severely restricted in times of crises (Allen et al. 2011). While in times of crises one might feel overwhelmed by external forces, scenario planning can help to identify leverage points in a system where processes can be influenced. Such points can be modifications of existing elements of research design or management, or new creative solutions in response to disruptions. For example, the project team of *Biocultural Diversity in Farming Landscapes of the Global South*[2], has emphasized on leverage points and researchers' agency which helped 1. to identify the capacity of researchers to influence the research process, which included efforts to intensify communication within the team and with partner organizations; 2. to modify research design and data collection; and 3. to set up health risk management plans.

Draw from remote and digital methods for data collection

The pandemic has demonstrated that many research methods cannot be applied under conditions of social distancing and travel restrictions (see figure 1). Scientists across all disciplines, in particular those doing fieldwork in foreign countries, have had to come up with novel and efficient ways to collect data remotely. This has contributed to an enormous push for new data collection tools and methods (citizen science, social media data) while advancing existing technologies (e. g., online, phone and SMS surveys). Postill (2017, p. 67) argues that "there is nothing inherently inferior or illegitimate about researching local issues remotely". He adds that this is particularly true when the researchers have already had fieldwork experience in the places they study. Below, we share two concrete examples of recent experiences with remote methodologies and reflect on effectiveness, constraints and opportunities.

Example: Remote interviews with local stakeholders

The *Salidraajuj* project[3] addresses consequences of climate change and human activity on freshwater ecosystems and dependent human livelihoods in Morocco. Due to COVID-19, researchers experienced limited access to the field from February 2020 onwards. The collection of ecological data could partly be transferred from the German to the Moroccan researchers, and it was decided to re-engage with farmers who participated in previous fieldwork activities through phone interviews. From mid-March until November 2020, 80 interviews were conducted. While the team was initially skeptical of the effectiveness of this approach, both the willingness of local actors to engage with the researchers and the quality of gathered information exceeded the expectations. Phone calls were complemented with farmers' exchanges through *WhatsApp,* voice messages, and pictures or videos from the fields and of agricultural activities. The fact that researchers and respondents stayed in touch and data collection continued after the initial phone interview proved to be an advantage over one-off individual interviews. At the same time, the team experienced various limitations. First, observations (e. g., of farming activities and body language during interviews), which are important data for anthropologists, cannot be easily acquired through phone interviews. Comparing certain normative or socially desired responses with actual practices is therefore challenging. Second, it is difficult to build relationships of trust, which hampers the exchange of sensitive information, such as that related to land transactions and inheritance in addition to water use conflicts. Finally, although mobile phones are widely used nowadays, this method potentially excludes certain community members, such as rural women, who may have limited access to them.

Example: Remote participatory modeling

A central goal of the *LOCOMOTION* project[4] is to humanize *Integrated Assessment Models* which typically emphasize ecology and other natural sciences over the social sciences (Király and Miskolczi 2019). As a way of achieving this goal, stakeholders were asked to give their perspectives on the main issues of concern to European and global society under transitions towards a sustainable future. Under COVID-19 it was decided to conduct the stakeholder session virtually. The first stage involved a risk analysis whereby participants distributed across Europe stated the main social-ecological risks for society in relation to sustainability transitions. Reponses included risks to health under climate change, climate-induced migration, unequal access to resources and food and water security. These elicited responses then formed the basis for a fuzzy cognitive mapping (Martinez et al. 2018) exercise through which participants represented how they understand the systemic links and causal relations between the identified risks. The research team had previously assessed the range of remote technologies available to allow participants to express their understandings of systems. The open source modeling tool *Loopy*[5] was selected due to its functionality and accessibility in terms of licensing, computing requirements, and user friendliness. To reduce complexity, a detailed schedule with specific timings and tasks for each team member has been drawn up, as opposed to following the usual flexible semi-structured flow that characterizes in-person

1 For example, during the emergence of COVID-19 a PhD project within the project *TransTourism – Transdisciplinary Science for Sustainable Tourism* has been adapted towards comparing impacts of tourism on the environment and community resilience before and during COVID-19 pandemic: *https://transtourism.leibniz-zmt.de*.
2 *https://www.bioculturaldiversity.de/scenarios-covid-19-pandemic*
3 *https://salidraajuj.uni-landau.de*
4 *https://www.locomotion-h2020.eu*
5 *https://ncase.me/loopy*

stakeholder participation. In conducting these tasks remotely, the research team encouraged stakeholders to digitally model their perspectives and so directly "speak" in the common modeling language of the project. This facilitated the integration of research questions and stakeholder understandings of complex systems into the project and set the tone for future iterative consultations.

As the two above examples demonstrate, during the pandemic the gathering of critical context-sensitive information, typically through field visits, in-person interviews or group meetings, has increasingly been conducted virtually. Given the recent advancement and spread of digital technologies, the use of digital methods has become more feasible and popular, even in remote corners of the world. However, while such methods offer considerable advantages for place-based social-ecological research, several ethical, methodological, and practical challenges and limitations must be considered (Dodds and Hess 2020). These include issues of data robustness and confidentiality, questions around the remuneration of respondents, and barriers that may prevent people from participating such as lack of (stable) internet access, experience with technology, and a suitable safe and quiet space to speak. In addition, having established respondent contacts and knowledge of the area is deemed to be essential for conducting effective remote research.

Seize opportunities for making social-ecological research and partnerships more responsible and just

In a crisis situation society is confronted with its weaknesses and opportunities for improvement. As a result, the COVID-19 pandemic pushes for fundamental long-term changes in place-based social-ecological research practices. Here, we highlight three important areas of action.

First, to enhance the resilience of future research in times of crises, it is crucial to prioritize the independent and equitable involvement of partners abroad. This is often realized in a limited manner, especially when the research takes place in geographically distant areas challenged by a lack of infrastructure (Landau 2012, Owusu-Nimo and Boshoff 2017). A more inclusive research approach would contribute significantly to the resilience of a project, and, if sufficiently empowered, enable local research activities under restrictions on international travel. In the current situation, funding agencies might be open for changes not only in scope, methods, and timing, but also in the content of research projects including a greater inclusion of partners. This involves more engagement and capacity building of local partners across all steps of the research process, including design, funding strategies, project implementation, publications, and policy outputs. For example, in the *Salidraajuj* project presented above, the travel restriction affected researchers from Germany and Morocco equally in the first months of the pandemic but the Moroccan researchers were able to resume fieldwork earlier. Through partnerships with Moroccan researchers, and after reconfiguring funding modalities, it was possible to resume data collection. Such an approach can become an active strategy for responsible research that is characterized by equity and just research partnerships which outlast crisis-related constraints.

A more inclusive and holistic research approach encourages more collaborative knowledge production, co-design, and implementation. These are core principles of transdisciplinary research offering a rich portfolio of concepts and methods for greater integration of different forms of knowledge and actors (Bergmann et al. 2012, Biber-Freudenberger et al. 2018). Transdisciplinary research is designed to integrate the needs of society into research questions and to find solutions to current problems. Crisis situations that affect entire social-ecological systems can cause already existing challenges to intensify and multiply but also might lead to shifting priorities. Transdisciplinary research therefore has the potential to help non-academic actors respond to these challenges and quickly adapt their research questions to the new conditions accordingly.

Second, for effective responses to fieldwork disruptions, funding agencies and administrations must allow for more flexibility in fund provisions and meaningful resource allocation to partners This is crucial as the leeway for sharing resources and responsibilities with research partners is shaped by funding provisions, yet regulations rarely take this into account. Resources may be needed for financing tailored capacity building, hiring local staff, long-term research, or the purchase of electronic tools such as portable solar panels and batteries for data collection to foster equal engagement and empowerment of research partners in place-based research endeavors.

Third, knowledge co-production could be further fostered through liaising with project partners to benefit from institutional open access data repositories and library resources. This could usher in a new wave of fruitful and symmetrical scientific collaboration. As illustrated above, the COVID-19 crisis requires researchers to be highly flexible and innovative in finding ways to substitute field data or shift research foci. Open access data repositories could help to enable reuse of existing data or focus on cross-project syntheses.

Crises like the current pandemic urge us to rethink and redesign research partnerships and projects. This may pave the way towards just partnerships, responsibility, and equity in place-based social-ecological research. The ambition is to go beyond the practical aspects of "keeping things going" in a business-as-usual mode, and take advantage of the window of opportunity for systemic change offered by the crisis.

Conclusions

The COVID-19 pandemic has vividly illustrated the vulnerability of place-based research to crises and sudden disruptions. Disruptions in place-based research are not exclusive to social-ecological research and therefore most of our recommendations could also be applied to other research contexts. First, we recommend a flexible and adaptive design, management, and implementa- >

tion of research projects. This includes adoption of a modular research design, risk assessment plans as well as remote and digital data collection methods, which can help to anticipate and adapt to disruptions of place-based social-ecological research in the short- and medium-term. Such adjustments can be addressed at project or even individual level. Second, we recommend a fundamental shift towards more equitable conditions in how research is planned, funded, administered, and implemented. Strategies falling under this category include steering changes in funding modes, fostering open access to research data and publications and, more importantly, the inclusion and empowerment of local research partners in multiple ways for a more just, ethical, and sustainable research landscape.

While some of these recommendations can be more easily implemented, others require determined collective action and the reorientation of social-ecological research toward truly lived transdisciplinarity.

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